PROPULSION DIRECTORATE

Monthly Accomplishment Report
October 2005

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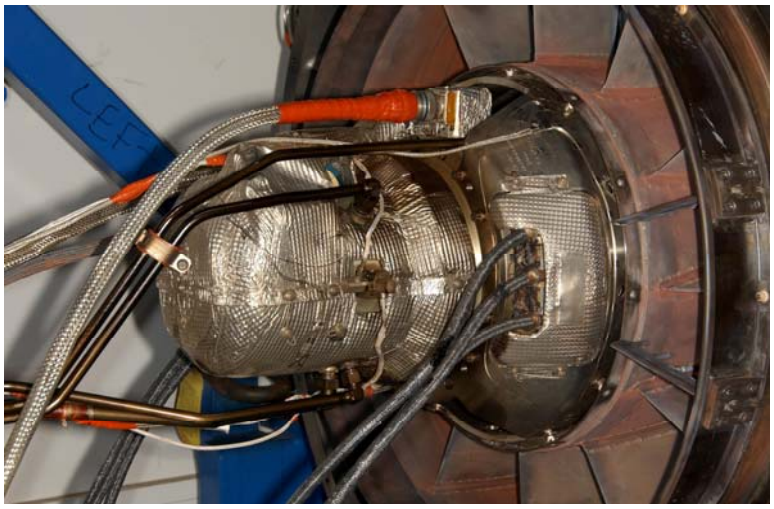
GLOBAL HAWK LOW PRESSURE GENERATOR AND ELECTRIC STARTER DEMONSTRATE ALTITUDE OPERATION: On 12 October 2005, the Propulsion Directorate achieved a major milestone by successfully completing demonstration tests simulating altitude operation of a low pressure (LP) turbine-driven 270 Vdc, 75-kW generator mounted onto an AE3007H engine. The development of a 28 Vdc electric starter/generator (S/G) was accelerated to coincide with the test schedule of the 75-kW generator, and it was also successfully demonstrated on this engine. AFRL/PR's Advanced Technology Demonstration (ATD), titled Range Altitude Power Innovative Technology (RAPIT), was the foundational program and was coordinated between AFRL/PR and the Global Hawk Program Office (ASC/RG). Its purpose was to develop Integrated High Performance Turbine Engine Technology (IHPTET)-sponsored engine upgrades and electric power enhancements for transition to the RQ-4 Global Hawk. The integration of the LP generator and starter/generator with the engine was accomplished through a team effort by Innovative Power Solutions (IPS, the generator contractor), Rolls-Royce Corporation, LibertyWorks™, Northrop Grumman, and AFRL/PR's Turbine Engine and Power Divisions. This generator first operated successfully while installed on an AE3007 engine in 2003 during sea-level testing at Rolls-Royce. These sea level tests were repeated again at Rolls-Royce in June 2005 to verify the generator and engine installation modifications were incorporated after the 2003 tests. The final test goals were to verify the LP Generator thermal environment and engine performance with LP Generator power extraction at Global Hawk mission altitudes. Simulated altitude testing was performed at Arnold Engineering Development Center (AEDC) because the AEDC facilities provided unique capabilities needed to simulate high-altitude operation of the AE3007H engine. The planned set of steady-state and transient test conditions was achieved for both the engine and generator, including peak 75 kW output at simulated mission altitudes. While the LP Generator was the primary component to be demonstrated in the AEDC test



Global Hawk LP turbine-driven generator

Global Hawk electric starter/generator

series, the RAPIT team had also planned for contingency testing of a 28 Vdc starter/generator during the same test period. The S/G, also developed and built by IPS through a Phase II SBIR program, was first demonstrated in sea-level engine starts at Rolls-Royce in June 2005. The goal of testing the S/G at AEDC was to demonstrate in-flight engine restarts as a potential future capability for the Global Hawk, and the S/G accomplished its planned test set of engine restarts at multiple simulated altitude/Mach points. This testing has unequivocally accomplished the joint AFRL and ASC/RG goals of developing Global Hawk power upgrades, bringing both the LP Generator and S/G to a Technology Readiness Level (TRL) of 6+, and enabling transition of these technologies to ASC/RG for production development. (Mr. S. Sepeck, AFRL/PRTP, (937) 255-1466 and Mr. E. Durkin, AFRL/PRPG, (937) 255-6206)

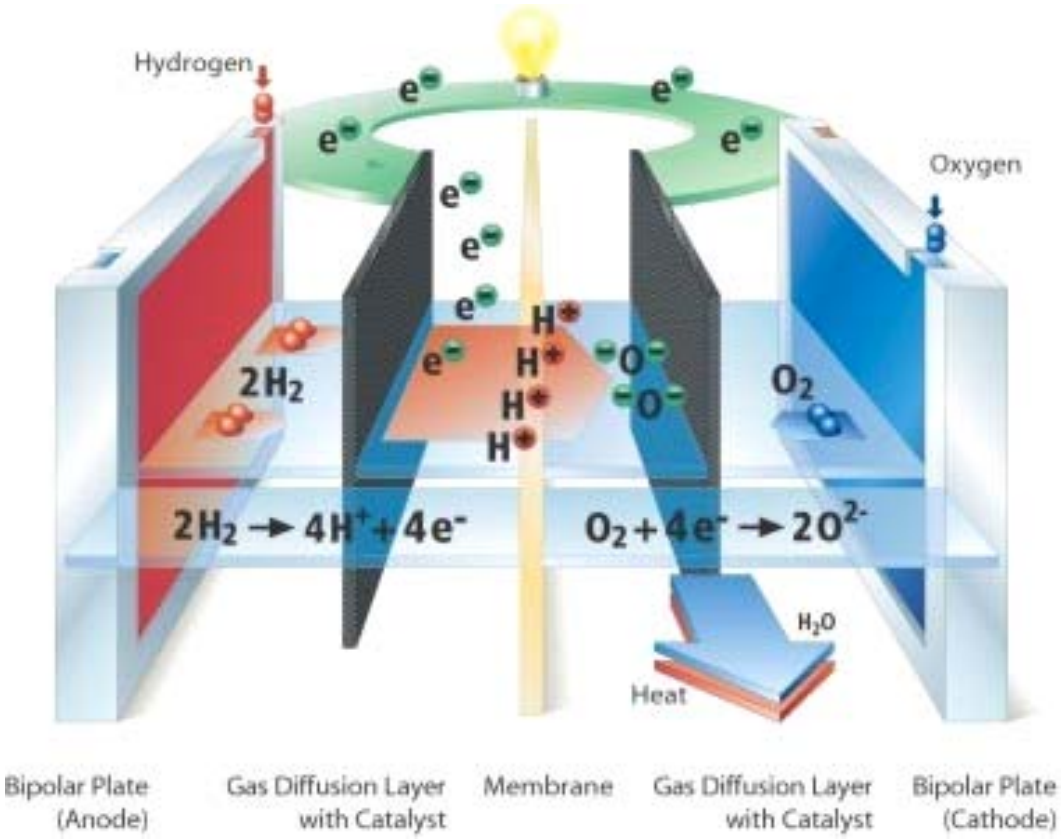
FINANCIAL MANAGEMENT PERSONNEL CAPTURE MULTIPLE AWARDS: The Propulsion Directorate's Financial Management Division (AFRL/PRF) took home awards in five different categories at the 2005 AFRL Financial Management and Comptroller Annual Awards. AFRL/PRF and AFRL/VAF were named co-winners of the Financial Management and Comptroller Organization of Year. AFRL/PRF was also recognized for Outstanding Contribution to Transformation for work on the Wide Area Work Flow (WAWF) system. Furthermore, Capt Steven J. Bolster was named the Financial Analysis Officer of the Year. The winners in these three categories will go forward to compete for awards at the Air Force Materiel Command (AFMC) level. In addition to these awards, two more AFRL/PRF personnel were recognized with AFRL-only awards. Mr. Dan Schaefer was named the Budget Assistant/Technician of the Year, and Mr. Eric Talley was named the Trainee of the Year. (Mr. P. Mitchell, AFRL/PRF, (937) 255-3044)


Mr. Eric Talley was named Trainee of the Year

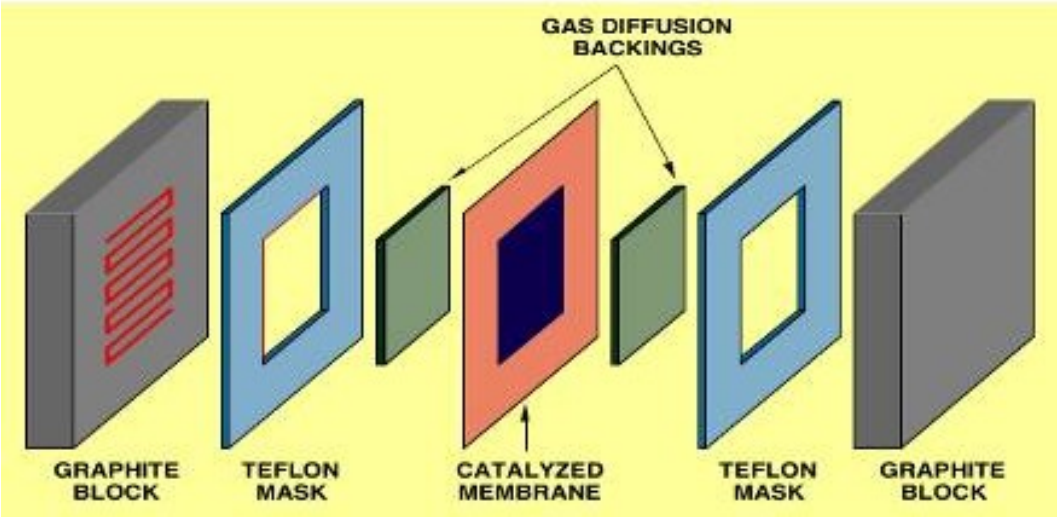
PROGRESS IN PROTON EXCHANGE MEMBRANE FUEL CELL RESEARCH: AFRL is conducting in-house Proton Exchange Membrane Fuel Cell (PEMFC) research in order to help fuel cells become viable power sources for Air Force applications. This research involves investigating critical fuel cell materials, their reliability, and issues with energy density. A joint effort between AFRL's Propulsion and Materials and Manufacturing Directorates has resulted in new polymer systems for this application. A low-cost, hydrocarbon-based (6F-SPTES-50[*]) polymeric system with endcapping groups was synthesized and characterized for potential application as fuel cell membranes. High molecular weight polymers were synthesized and fabricated into tough films which exhibited high intrinsic proton conductivity. Operational Membrane Electrode Assemblies (MEAs) or single fuel cells were successfully fabricated with this material and the overall performance was similar to state-of-the-art Nafion® at both low and

[*] SPTES = Sulfonated Polyarylenethioethersulfone

high temperatures (100°C). The high thermal stability and high intrinsic proton conductivities of 6F-SPTES-50 qualify these polymers to be potential cost-effective alternatives to Nafion® as electrolyte separators for PEMFCs. The results of this work were presented at the recent 3rd International Energy Conversion Engineering Conference (IECEC) held in San Francisco. (Dr. S. Rodrigues, AFRL/PRPS, (937) 255-2848)



Schematic showing the operation of the Proton Exchange Membrane Fuel Cell



Schematic showing the construction of the Proton Exchange Membrane Fuel Cell

ROCKET RESEARCHERS EARN JANNAF BEST PAPER AWARD: Drs. Peter Strakey, Richard Cohn, and Douglas Talley of the Propulsion Directorate's Space and Missile Propulsion Division recently received the JANNAF† Liquid Propulsion Subcommittee's 2004 Best Paper Award. These researchers were honored for their paper titled, "The Development of a Methodology to Scale Between Cold-Flow and Hot-Fire Evaluations of Gas-Centered Swirl Coaxial Injectors." This paper was presented at the 52nd JANNAF Propulsion Meeting/1st Liquid Propulsion Subcommittee Meeting held in Las Vegas, Nevada, in May 2004. The award will be presented at the upcoming 53rd JANNAF Propulsion Meeting/2nd Liquid Propulsion Subcommittee/1st Spacecraft Propulsion Subcommittee Meeting to be held in December 2005 in Monterey, California. (Dr. I. Wysong, AFRL/PRSA, (661) 275-5206)

Drs. Peter Strakey (top), Richard Cohn (bottom L), and Doug Talley (bottom R) received the JANNAF Liquid Propulsion Subcommittee's 2004 Best Paper Award

† JANNAF = Joint Army-Navy-NASA-Air Force

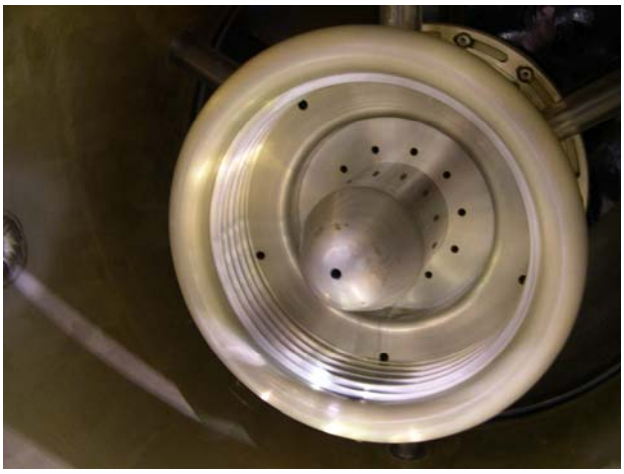
SUPERCONDUCTIVITY GROUP AWARDED THIRD CONSECUTIVE AFOSR STAR TEAM AWARD: The Superconductivity Group of the Propulsion Directorate's Power Generation Branch (AFRL/PRPG) was recently awarded its third consecutive Star Team Award by the Air Force Office of Scientific Research (AFOSR). The first of these three awards came in 2001, and the latest award extends the Superconductivity Group's Star Team status through 2006. The purpose of the AFOSR Star Team Award is to recognize excellence in basic research within the AFRL Technical Directorates. The Star Team criteria restricts the number of awards to no more than 10% of all 6.1 (i.e., Basic Research) tasks. The Superconductivity Group, led by Dr. Paul Barnes, was again selected for the award based on their research accomplishments in the areas of magnetic flux pinning and ac losses in the YBCO (yttrium barium copper oxide) superconductor. The Star Team Award rewards team achievement, fosters excellence throughout the technical directorate research community, showcases Air Force research, and promotes the critical role of fundamental research within the Air Force's broad technology thrusts. (Dr. P. Barnes, AFRL/PRPG, (937) 255-4410)

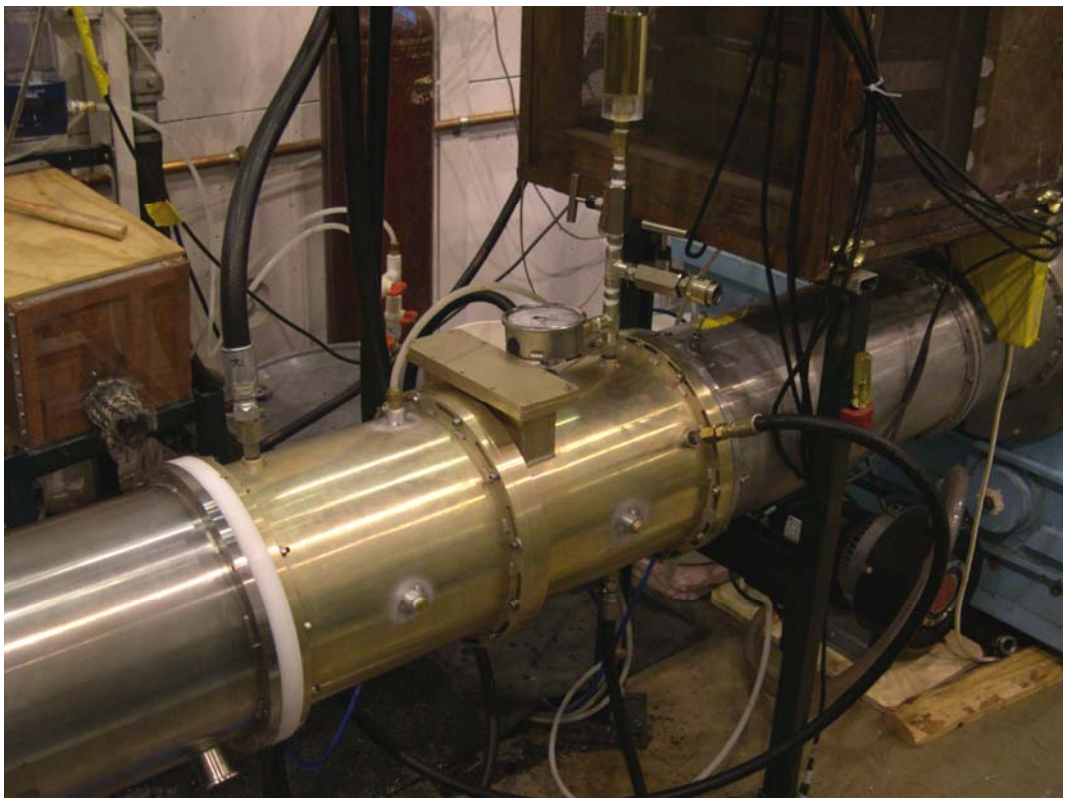
The Superconductivity Group was awarded its third consecutive AFOSR Star Team Award

HIGH PRESSURE OIL SWITCH SUCCESSFULLY TESTED: AFRL's Directed Energy and Propulsion Directorates recently integrated novel oil filled switch technology into AFRL/DE's General Rep-rate Universal Multi-purpose Pulser (GRUMP). The switch was developed by AFRL/PR's Power Division over the last three years. The device employs advances in switching technology made by a team of researchers at the University of Missouri-Columbia, Alpha-Omega Power Technologies, and The Boeing Company. The switch's unique compact design utilizes high pressure, flowing hydraulic fluid as the medium for repetitive high voltage switching. Since hydraulic fluid is already resident on most airframes, it does not constitute a new material for an air platform. Furthermore, the switch has the advantage of being far more

compact than the standard blown-gas switches commonly used by AFRL/DE. The recently completed initial operating tests of the oil-filled switch were successful, with the GRUMP pulser producing diode voltage and current as normal with no change in the output performance of the device. The next phase of testing will consist of scanning the pressure, voltage, and gap settings of the switch to determine its full operational profile. After completion of that phase of testing, the team will begin lifetime testing. (Dr. S. Heidger, AFRL/PRPE, (937) 255-6932 and Dr. D. Shiffler, AFRL/DEHP, (505) 853-3906)

Switch hardware


Assembled switch cathode electrode


High Pressure Oil Switch Integrated into GRUMP Pulser